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Community Rehabilitation Outcomes for Different Stroke Diagnoses: An Observational Cohort Study

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KEYWORDS	Abstract Objective: To determine the differences in functional and cognitive rehabilitation
Brain injuries;	gains made in community-based rehabilitation following a stroke based on stroke diagnosis
Rehabilitation;	(left or right hemisphere, hemorrhagic, or ischemic).
Stroke	Design: A 12-month follow-up observational retrospective cohort study.
Stroke	Setting: Staged community-based brain injury rehabilitation.
	Participants: Clients (N=61) with hemorrhagic left brain stroke (n=10), hemorrhagic right
	brain stroke (n=8), ischemic left brain stroke (n=27), or ischemic right brain stroke (n=16)
	participating in rehabilitation for at least 12 months.
	Intervention: Not applicable.
	Main Outcome Measures: The Mayo-Portland Adaptability Inventory-4 (MPAI-4) was completed
	at admission and 12 months post admission to staged community-based brain injury rehabilita-
	tion by consensus of a multidisciplinary team.
	<i>Results</i> : After 12 months in staged community-based brain injury rehabilitation, the study pop-
	ulation made significant gains in Total (P <.001) and across Ability (P <.001) and Participation
	(P<.001) subscales of the MPAI-4. All diagnostic groups made significant gains in Participation
	T-scores, and no groups made significant gains in Adjustment. The ischemic left and right hemi-
	sphere stroke groups also made significant gains in Ability and Total T-scores from admission to
	12 months. Clients with ischemic left hemisphere stroke had more severe limitations in motor
	speech (P <.05) than clients with right hemisphere stroke at admission and/or review and were
	also more impaired in verbal communication (P <.01) than the hemorrhagic right hemisphere
	group at admission.
	Conclusions: There are some differences in outcomes on presentation to rehabilitation based
	on type of stroke; there are also differences in rehabilitation gains. Improvement in physical

List of abbreviations: ABI, acquired brain injury; ANOVA, analysis of variance; MPAI-4, Mayo-Portland Adaptability Inventory-4 (MPAI-4). Supported by Brightwater Care Group as part of routine data collection and quality assurance activity. Presented in part to the World Congress for Neurorehabilitation, February 7-10, 2018, Mumbai, India. Cite this article as: Arch Rehabil Res Clin Transl. 2020;2:100047.

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ability does not always translate to improvement in social participation and independence; those with right brain stroke need further assistance to translate physical gains into participatory outcomes.

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Stroke is a leading cause of disability worldwide.¹ In 2016, there were an estimated 13.7 million new stroke cases, 5.5 million deaths, and 116.4 million disability-adjusted life years because of stroke.² Some survivors of stroke experience ongoing impairment, with 2015 Australian hospital data indicating that 40% of people who experienced a stroke had a resulting disability.³ This group may require continued specialist intervention to support recovery and reintegration to the community, with increasing evidence for providing community-based and specialist rehabilitation services following stroke,^{4–6} and cumulative evidence has demonstrated the benefits of a variety of interventions.⁷

Staged community-based brain injury rehabilitation is a novel model of care providing postacute therapy and care services to support recovery from illness or management of chronic illness or disability,^{8–10} responding to the individual's needs as these change over time. Individuals receive rehabilitation in a community-based residential facility within dedicated units based on the degree of care need. Clients graduate through several stages of care with decreasing levels of support as their independence and functional abilities improve. Previous studies have demonstrated the overall effectiveness of the model.⁸

However, rehabilitation following discharge to the community is not consistently recommended.^{4,11,12} Lynch et al found that 37% of 292 hospital in-patients with stroke were not assessed for rehabilitation, and 10% of patients who were responsive, not refusing treatment, and had not fully recovered were not offered rehabilitation.^{4,12} This is despite many clinical guidelines stating that all patients should have their rehabilitation needs assessed, and those with ongoing needs should have access to continued rehabilitation (eg, Australian Clinical Guidelines for Stroke Management, UK National Clinical Guidelines for Stroke).^{13,14} Inconsistent referral to rehabilitation following an acute episode of stroke is exacerbated by limited availability of extended community-based rehabilitation.

Survivors of stroke are a heterogeneous group, and the differences in outcome between type and side of stroke are well established. Research has found that people with left hemispheric ischemic strokes have poorer functional outcomes than those with right hemispheric ischemic strokes.¹⁵ Nayar et al¹⁶ proposed that the brain hemisphere in which stroke occurs manifests different outcomes for individuals. An early study by Bernspng and Fisher¹⁷ concluded that people with right and left hemispheric stroke differed in motor skills; however, they had similar activities of daily living skills. Further, people with ischemic stroke have higher cognitive, strength, and motor activity levels than people who experience hemorrhagic stroke.¹⁸ In

the initial months following stroke, hemorrhagic stroke is also likely to be more severe and have a higher risk of death than ischemic stroke.¹⁹ However, a majority of these findings derive from samples of survivors of stroke receiving acute care or inpatient rehabilitation, whereas outcomes for people receiving community-based rehabilitation are not well documented.

The current study aims to provide preliminary observational data about the gains that might be expected to occur in a small representative sample of admissions to a staged community-based brain injury rehabilitation service. Specifically, this study aimed to investigate staged communitybased brain injury rehabilitation outcomes based on stroke diagnosis (left or right hemisphere, hemorrhagic or ischemic) and to determine areas in which rehabilitation gains were made. The study had 2 objectives: (1) measure improvements in ability, adjustment to injury, and participation after 12 months in community-based rehabilitation following a left or right/ ischemic or hemorrhagic stroke and (2) compare improvements made between diagnostic groups. We hypothesized that all groups would improve as a result of staged community-based brain injury rehabilitation and that differences in outcomes would exist between the 4 diagnostic groups.

Method

Study design

We performed an observational retrospective cohort study of clients entering staged community-based brain injury rehabilitation between June 2010 and July 2017 following an ischemic or hemorrhagic stroke in the left or right hemisphere of the brain.

Setting

The setting was a purpose-built, community-based residential rehabilitation facility providing staged communitybased brain injury rehabilitation for people aged 18-65 years with an acquired brain injury (ABI) of any cause, supported by an interdisciplinary team. The facility has 43 residential beds across 8 small group houses (accommodating 4-5 clients each), 8 independent living units, and 10 places for clients living in their own home. All stages of brain injury rehabilitation are supported, from profound physical disability (including clients still in a minimally conscious state) to higher level cognitive rehabilitation. Clients diagnosed as having stroke comprise 50% of all rehabilitation clients. The facility provides progressively different levels of support to meet differences in physical, sensory, and care needs. Clients are allocated a house based on rehabilitation need, where stage 1 represents full assistance 24 hours per day, and stage 10 represents full independence. As a client's physical and cognitive abilities improve, they move through the houses with the rehabilitation program adapting to their changed needs.⁸

Participants

All clients of the staged community-based brain injury rehabilitation facility between June 2010 and July 2017 with full data available, who had a primary diagnosis of hemorrhagic left brain, hemorrhagic right brain, ischemic left brain, and ischemic right brain stroke.

Data collection

Demographic data (age, sex, and time since injury) were collected on admission to the facility. Mayo-Portland Adaptability Inventory-4 (MPAI-4) data are routinely collected at admission and 12 months by consensus from the treating interdisciplinary clinical team with the purpose of improving service provision. All data were deidentified for this study. These routinely collected data are classed as service evaluation, which does not require ethical approval for research in Australia.

Mayo-Portland Adaptability Inventory-4

The MPAI-4 is a 29-item measure designed to assess rehabilitation progress following ABI. The MPAI-4 comprises 3 subscales to assess a range of physical, cognitive, emotional, behavioral, and social problems people may encounter following ABI: Ability, Adjustment, and Participation.²⁰ The Ability subscale includes 12 items to assess sensory, motor, and cognitive abilities. The Adjustment subscale comprises 12 items to assess mood and interpersonal interactions. The Participation subscale provides a measure of societal participation and includes 8 items mapping initiation, managing money, and social contacts. Each item is rated on a scale ranging from 0 (no limitation) to 4 (severe limitation).

MPAI-4 scores are combined overall and by subscale and converted to a T-score with reference data from a large US sample published by the MPAI-4 developers. The sample gives a normal distribution mean score of 50 ± 10 .²⁰

Data analysis

Data analysis was conducted using Stata software.^a Summary statistics were run on demographic data. Participants were stratified into 1 of 4 diagnostic groups based on primary diagnosis: hemorrhagic left brain, hemorrhagic right brain, ischemic left brain, and ischemic right brain.

To analyze MPAI-4 data, nonparametric analyses were conducted to account for the small sample. Wilcoxon signed rank and Kruskal-Wallis 1-way analysis of variance (ANOVA) models were used to analyze within- and betweengroups data, respectively. Post hoc comparisons using Mann-Whitney with a Bonferroni adjustment accounting for the number of multiple comparisons (k=6) were conducted to examine between-group differences. Therefore, the median and interquartile range are reported for item, subscale, and total scores.

Results

Sixty-one people (39 male, 22 female) were included in the study. Demographic data are summarized in table 1. Participants were aged 22-64 years (median, 53y) on admission. There was a significant difference in the median age between the 4 groups; the ischemic right brain group were 10 years older on average. Individuals were admitted to the service at differing times since injury (range, 106d-35y; median, 473d) and were admitted from acute care, postacute care, or their own home. Although the hemorrhagic right brain group presented with the greatest disability, there was no significant difference in severity of disability between groups on admission, measured using the UK Functional Independence Measure.^{21,22}

The whole population showed significant improvement in Total, Ability, and Participation T-scores but not Adjustment from admission to 12-month follow-up (table 2). The largest overall improvements were observed for components of the Participation subscale, including transportation, self-care, residence, and managing money (fig 1). An average decline in appropriate social interaction occurred after 12 months of rehabilitation.

For each diagnostic group, changes from admission to 12 months are summarized and presented with results of within-group comparisons in table 2. All groups made significant gains in Participation T-scores over 12 months, and no group made significant gains in Adjustment. The ischemic left brain and ischemic right brain groups also made significant gains in Ability and Total T-scores from admission to 12 months.

Hemorrhagic left brain stroke

People with hemorrhagic left brain stroke presented to staged community-based brain injury rehabilitation with the least impairment in Participation and showed the least impairment in Total, Adjustment, and Participation at follow-up. However, statistically significant gains were made only for Participation T-scores. Figure 2 displays the item-level changes from admission to 12-month follow-up for each group. Although there was clear improvement in Participation items, there was some decline in Ability and Adjustment items, specifically social interaction, irritability, verbal communication, and vision. People with hemorrhagic left brain stroke were independent in self-care after 12 months of rehabilitation.

Hemorrhagic right brain stroke

On admission, the hemorrhagic right brain stroke group had the most severe impairment of all diagnostic groups (ie, highest median Total, Ability, and Participation T-scores). After 12 months, people with hemorrhagic right brain stroke made significant gains in only Participation T-scores. Compared with other groups, this group continued to show

Table 1 Demographic and injury characteristics of the total population and each type of stroke cohort						
Characteristics	Total Sample (n=61)	HLB (n=10)	HRB (n=8)	ILB (n=27)	IRB (n=16)	
Age (y), mean (range)*	50.7 (22-64)	47.8 (36-58)	47.0 (35-62)	49.1 (22-63)	57.1 (45-64)	
Male:female (%)	63.9:36.1	90.0:10.0	37.5:62.5	66.7:33.3	56.3:43.7	
Time since injury (d), median	473	360	691	490	454	
Severity of disability	84.0 (60-99)	83.0 (77.5-101.5)	56.0 (29-86)	86.5 (67-101)	85.0 (48-93)	
(UK Functional Independence Measure), median (IQR)	(n=43)	(n=8)	(n=6)	(n=16)	(n=13)	

Abbreviations: HLB, hemorrhagic left brain; HRB, hemorrhagic right brain; ILB, ischemic left brain; IQR, interquartile range; IRB, ischemic right brain.

* Kruskal-Wallis: significant difference.

the greatest levels of impairment across Total, Ability, and Participation scores after 12 months. People with hemorrhagic right brain stroke made gains in all Participation items but declined in Adjustment items (irritability, sensitivity, social interaction and self-awareness) (see fig 2).

Ischemic left brain stroke

The ischemic left brain group presented with the least impairment in Total, Ability, and Adjustment compared with other diagnostic groups, with scores similar to those with hemorrhagic left brain stroke; however, they did not improve to the same level as the hemorrhagic left brain stroke cohort after 12 months. Participants with ischemic left brain stroke made significant gains in Total, Ability, and Participation T-scores over 12 months. Figure 2 shows that the largest amount of change for this cohort occurred in Participation items: transportation, residence, and selfcare. The ischemic left brain cohort had no impairment in social interaction after 12 months of staged communitybased brain injury rehabilitation.

Ischemic right brain stroke

Participants with ischemic right brain stroke were admitted with similar impairments to the hemorrhagic right brain stroke group. Specifically, this group presented with the second highest median Total, Ability, and Participation T-

Table 2	MPAI-4 T-scores at admission and	12 months	post admission f	for the total sa	ample and	grouped by	type of stroke cohort

MPAI-4 T-score	Median (IQR)	Z	P Value			
	Admission 12-mo Review		Change			
Ability						
HLB $n = 10$	51.0 (50-53)	48.0 (45-52)	0.5 (-1 to 6)	1.075	.282	
HRB n=8	54.0 (46-58)	52.0 (40.5-58.5)	1.0 (–4 to 5.5)	0.493	.622	
ILB n=27	51.0 (47-57)	49.0 (42-55)	3.0 (0-6)	3.211	<.005*	
IRB n=16	53.0 (48.5-57.5)	47.0 (45.5-54)	4.5 (2-6.5)	2.747	<.01*	
Total n=61	51 (47-51)	49 (45-55)	3.0 (0-6)	4.160	<.001*	
Adjustment						
HLB $n = 10$	50.0 (48-52)	46.0 (41-56)	2.5 (-5 to 8)	1.226	.220	
HRB n=8	52.0 (47.5-55.5)	51.0 (44-53.5)	1.5 (–2 to 3.5)	0.703	.482	
ILB n=27	48.0 (45-51)	49.0 (44-53)	0.0 (-4 to 5)	0.579	.563	
IRB n=16	54.0 (49-55.5)	52.0 (45.5-56.5)	0.0 (-4.5 to 7)	0.570	.568	
Total n=61	50 (46-55)	50 (44-54)	1.0 (–4 to 5)	1.426	.154	
Participation						
HLB $n = 10$	49.0 (46-59)	44.0 (41-62)	4.0 (3-8)	2.044	<.05*	
HRB n=8	58.0 (45-68)	50.5 (40.5-58)	3.0 (0.5-9)	1.968	<.05*	
ILB n=27	50.0 (44-59)	46.0 (42-57)	4.0 (0-9)	2.946	<.005*	
IRB n=16	57.0 (53-60.5)	48.5 (44-55)	4.5 (0-14.5)	2.488	<.05*	
Total n=61	53 (46-59)	46 (42-57)	4.0 (0-9)	4.822	<.001*	
Total						
HLB $n = 10$	49.5 (47-57)	44.5 (41-56)	3.5 (1-6)	1.636	.102	
HRB n=8	55.0 (45.5-59)	52.0 (40-59)	2.5 (-2 to 6)	0.853	.394	
ILB n=27	48.0 (44-54)	46.0 (42-55)	2.0 (0-5)	2.760	<.01*	
IRB n=16	54.0 (49-57.5)	49.0 (45-54)	3.0 (-1.5 to 9)	2.099	<.05*	
Total n=61	52 (46-57)	47 (42-55)	3.0 (0-6)	3.814	<.001*	

Abbreviations: HLB, hemorrhagic left brain; HRB, hemorrhagic right brain; ILB, ischemic left brain; IQR, interquartile range; IRB, ischemic right brain.

* *P*<.05.

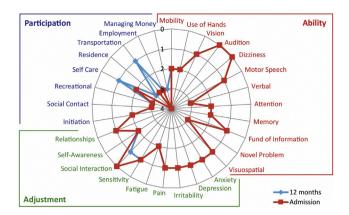


Fig 1 MPAI-4 radar chart showing median change in 29 items from admission to 12 months post admission for the total cohort (n=61). Items are arranged as spokes in the wheel. MPAI-4 scores are inverted, and levels are arranged from severe problem/limitation at the center (4) to no problem/limitation on the outer perimeter (0). The red line represents scores on admission to staged community-based brain injury rehabilitation, and the blue line represents scores following 12 months of staged community-based brain injury rehabilitation.

scores and the highest median Adjustment score. This group made significant gains in Total, Ability, and Participation T-scores over 12 months. Improvement in items across Ability and Participation for this group can be observed in fig 2, largely in self-care, mobility, use of hands, memory, fund of information, and visuospatial abilities. Improvement in Participation for this group was item specific: self-care and initiation. There was a decline in Adjustment items: sensitivity and depression. The ischemic right brain group appear more depressed and sensitive to their symptoms on admission and 12 months post compared with other groups.

Between-group analysis

ANOVA models did not show a significant difference between diagnostic groups for subscale T-scores at admission and 12 months. For individual items, there was a significant difference between the groups in motor speech at admission (P<.001) and at follow-up (P<.001) as well as in verbal communication skills at admission (P<.05). Pairwise comparisons demonstrated that the ischemic left brain group had more severe limitations than the hemorrhagic right brain group in motor speech at admission (P=.044) and review (P=.013) as well as more severe limitation in verbal communication (P=.009) at admission (table 3). The ischemic left brain group also had more severe limitation in motor speech compared with the ischemic right brain group at review (P=.005) but not admission.

Discussion

On average, the study population made significant improvements after participating in staged community-based brain injury rehabilitation for 12 months. There were differences in cognition and function at admission and 12 months later based on the diagnostic group. Importantly, this study illustrates that clients are being discharged from acute care after making gains in recovery of primary skills, such as use of hands and visuospatial skills, regardless of stroke type, and recovery continues in staged communitybased brain injury rehabilitation. However, findings indicate that people with ischemic left brain stroke have ongoing deficits in communication, and people with ischemic right brain stroke continue to have deficits in participation despite improvement in mobility and primary skills.

People with left hemispheric stroke had poorer functional outcomes than those with right hemispheric stroke, which is consistent with the findings of Hedna et al.¹⁵ People with left hemispheric stroke had poorer motor speech ability than people with right hemispheric stroke at admission and 12 months. This supports the well documented finding that stroke lesions to the left hemisphere often cause speech difficulties.^{17,23} Interestingly, verbal communication only differed significantly at admission, which is suggestive that those with left hemisphere stroke improved to a greater extent during 12 months of rehabilitation. Despite these poorer functional outcomes, people with hemorrhagic left brain stroke were independent in self-care 12 months after admission to staged community-based brain injury rehabilitation, indicating the ability to use their skills for independent living. Social contact was low for this cohort, likely because of ongoing communication difficulties and not indicative of tendencies to socially withdraw. Meanwhile, greater functional outcomes for people with right hemispheric stroke did not translate into better participatory outcomes.

People with ischemic right brain and hemorrhagic right brain stroke made improvements in physical ability; however, the results of this study show that these gains are not translated into participation. Improvements in participation for those with ischemic right brain stroke were item specific in the area of self-care, with Initiation also improving, likely because of the increase in self-care. Research also suggests impeded awareness in those with right hemispheric stoke may be the cause of lower participation outcomes.²⁴ With little awareness of their limitations, people with ischemic right brain stroke cannot translate their ability into participation.

Greater functional outcomes for people with hemorrhagic right brain stroke contribute to a slow but consistent improvement in participation across a number of parameters, including self-care transportation and social contact. Overall, this cohort was more general in participatory outcomes and therefore continue to improve once in the community. While people with hemorrhagic right brain stroke made the most significant gains in Participation, their overall participation impairment remained the most severe at 12 months post admission. This may be because of the increased irritability and sensitivity to their symptoms.²⁵

The Australian Clinical Guidelines for Stroke Management (2017) state that rehabilitation following stroke should aim to maximize the participation of a person with stroke in the community.¹³ Acute care settings often rely on

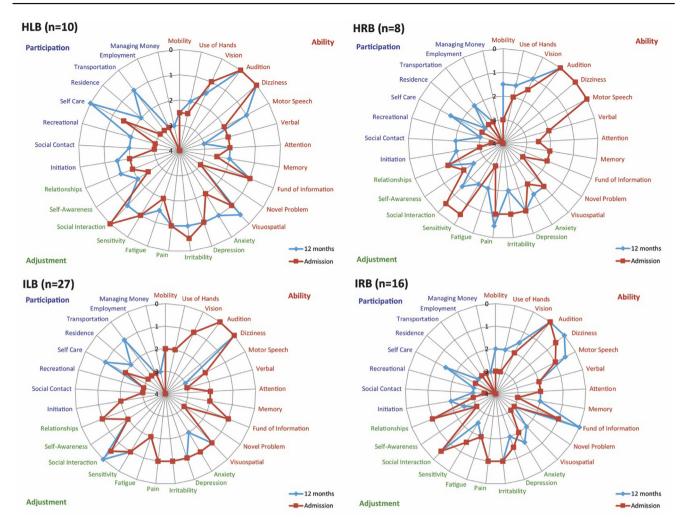


Fig 2 MPAI-4 radar charts showing median change in 29 items from admission to 12 months post admission for each type of stroke cohort. These show at a glance rehabilitation outcomes for each cohort across 12 months of staged community-based brain injury rehabilitation.

physical outcome measures to inform discharge and accommodation options.^{26,27} However, this study suggests that clinicians cannot rely on these measures to accurately predict participation and community independence of people with stroke upon discharge from acute care. It appears that those with ischemic right brain stroke struggle to translate their improvement in primary skills into independent living. Without a structured routine and prompting, people with ischemic right brain stroke are at risk of injury, harm, or homelessness.^{27,28} Research on stroke outcome by type of stroke is heavily focused on acute care and rehabilitation; more research on how participatory outcomes can be improved is required, regardless of physical capacity.

Furthermore, this study provides evidence of the importance for community rehabilitation staff to include potential participatory outcomes when goal setting or extending an individual's length of stay in staged community-based brain injury rehabilitation. There is a risk that gains in physical ability to perform tasks will be perceived as a reason to continue rehabilitation service provision when an individual may be beyond their ability to translate this into participatory gains. This is an essential consideration in discharge to the home environment.

Continued funding to support recovery is critical. There is a risk that people recovering from stroke who have good physical ability will not receive the funding required to support recovery from the cognitive effects of their brain injury. Improvements in participation are crucial to achieving independent living following stroke, and funding is required to support this skill development. This risk is demonstrated by the findings of Lynch et al,^{4,12} which indicate that many Australians in acute care following stroke are not recommended for rehabilitation.

In this study, providing a focus on increasing independence in the community while undergoing community rehabilitation increased participation for all groups. This study provides an additional perspective on outcomes following stroke that can be applied in a community setting.

Table 3	Summary of multiple comparisons for items with
a significa	nt omnibus Kruskal-Wallis ANOVA

Items	Admission		12-mo Review	
	z	P Value	z	P Value
Motor speech				
IRB vs ILB	-2.59	.058	-3.33	.005*
IRB vs HRB	-1.25	1.272	-1.03	1.000
IRB vs HLB	-1.58	.684	-1.65	.588
ILB vs HRB	-2.68	.044*	-3.07	.013*
ILB vs HLB	-79.00	2.592	-1.85	.390
HRB vs HLB	-2.01	.264	-2.24	.150
Verbal communication				
IRB vs ILB	-3.18	.009*	-2.50	.075
IRB vs HRB	-1.13	1.548	-0.61	1.000
IRB vs HLB	-1.51	.792	-1.57	.696
ILB vs HRB	-1.25	1.267	-1.44	.891
ILB vs HLB	-2.13	.198	-0.93	1.000
HRB vs HLB	-0.28	4.686	-0.84	1.000

NOTE. *P* value is Bonferroni adjusted, where nonadjusted *P* value is multiplied by the number of multiple comparisons per Kruskal-Wallis ANOVA (k=6).

P values >1 after Bonferroni adjustment are reported as P=1.000.

Abbreviations: HLB, hemorrhagic left brain; HRB, hemorrhagic right brain; ILB, ischemic left brain; IRB, ischemic right brain. * Comparison significant at 0.05 level.

Study limitations

This study is limited by low statistical power. For example, a minimum sample of 116 would be required to have 80% power to detect the largest nonsignificant subscale effect as significant, based on a 2-sample test with the smallest stroke cohorts (hemorrhagic left brain and hemorrhagic right brain groups), although this ranged to approximately 350 participants. Therefore, nonsignificant results may have clinical relevance within community rehabilitation settings. To confirm data trends, future research should use a larger study sample. This study did not include other stroke diagnoses: subarachnoid hemorrhage or bilateral. There was considerable variability and heterogeneity in stroke recovery in this small sample. Further, many factors can influence a person's recovery from stroke, including comorbidities, demographic qualities, and preexisting disabilities.^{26,29} Therefore, future studies should consider using multivariate analysis to control for possible confounding variables (eg, age, time since stroke, comorbidities). Outcomes from the current study are best generalized to patients with stroke aged between 18-65 years in community-based rehabilitation.

Conclusions

Considering a person's type of stroke in community rehabilitation can provide insight into which areas of rehabilitation require the most attention. Focusing purely on physical outcomes does not translate to people using those skills to assist independent living. It is important that rehabilitation programs and funding bodies consider people's likelihood of participating following stroke rather than their physical capacity to do so.

Supplier

a. Stata 21; StataCorp.

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